

time and by extrapolation beyond the last observation year (for the time being) there resulted the probability of a prediction of the thermal character of the following observation period of from 2 to 3 years, with the restriction that there is limitation to the distinction of the following chief types: Very warm—warm—normal—cool—cold. In order to test the utility of such predictions, the necessary calculations were carried out for each year of the period from 1900 to 1918, and in each of the 19 cases predictions were made for one, two, and three years. Although the analysis could not be carried out strictly since, on account of the short period of observation it was not possible to take an exact account of the long periods, still there were among the 57 predictions only 6 (16 per cent) that were found contrary to the temperature characteristics actually met with. A comparison of the calculated temperature departures with the observed departures by means of the "correlation method" showed that the probability of an "accidental" agreement of the previously calculated temperature departures with the actual departures is less than 1/10,000,000. The good agreement between experience and prediction permits us to view as correctly made the assumption that the agreement is entirely general and not only in the limits of the observational data at hand. Therewith the difficult problem of the prediction of the thermal character of the coming years is brought nearer relative to the principle of solution. It depends on the exceedingly important demonstration that in the temperature course in Germany there are contained actual periods of long duration.

The extension of the same investigation to other meteorological elements, as well as to the subdivisions of the year, is naturally very obvious. The execution of these investigations and their application I reserve for a further work already undertaken.

#### FORECASTING THE WEATHER, PARTICULARLY STORMS, FROM PILOT-BALLOON OBSERVATIONS.

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[Abstracted from *Comptes Rendus*, November 21, 1921, pp. 997-999.]

During more than two years in the meteorological service of the third army, having practised soundings by pilot-balloons every four hours day and night, the author tried to find a relation between the forms of

graphs of the horizontal projection of the course of the balloon, the data of synoptical weather charts, and the behavior of the barometer. From this comparison, he has deduced some conclusions which may be helpful in forecasting:

Different types of soundings have been classified as follows:

(1) Soundings at constant direction—those in which the lower and upper winds maintain sensibly the same direction.

(2) Soundings at an abrupt angle—the upper winds suddenly taking directions, generally from the west, contrary to those of the lower winds. Two layers of air, one gliding over the other without friction.

(3) Turning sounding—those in which the wind changes progressively its direction with altitude. For example, the lower winds being east or southeast, the upper winds becoming south-southwest and west with altitude. Two layers of air mutually penetrating.

(4) Soundings in which the winds of the layer 0 m. to 2,000 m. change direction rapidly with time and are from many different directions for neighboring stations.

(5) Soundings indicating winds weak and variable in direction up to great heights.

From the point of view of forecasting, the author makes the following remarks:

(1) The soundings of the first class are characteristic of cyclonic areas or the edges of anticyclones. The direction of the winds permit finding the direction of the center of the depression: it is usually found from the direction of the winds about 1,000 m. The changing of the general direction of the winds with time indicates the displacement of the center and permits determining the direction of this displacement.

(2) The soundings at an abrupt angle announce a distant depression. If successive soundings show the angle to be at higher and higher altitudes the depression is not to be feared. If the angle falls progressively, the depression is dangerous, the upper winds grow in force, the barometer falls. The upper winds appear to come from the low center.

(3) Soundings turning from east or southeast to south, southwest, and west with altitude are precursors of storms. Not only do they indicate a low area invading France from the southwest (Spain, Gulf of Gascony), but if the lower winds attain 4 or 5 m. one should look for the storm in 24 hours at the place of the sounding or in the neighborhood. In winter there will be snow.

(4) Soundings of the fourth class characterize the secondary depressions, barometric pockets. They show that in similar circumstances, only the winds of the 0-2,000 m. layer experience rapid variations with time. Above them one finds the winds that direct the principal depression. Similar soundings are also the precursors of storms in summer and snow in winter.

(5) Soundings of the fifth class are made on high anticyclonic plateaus or toward the center of vast cyclonic areas.

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